A method of joint inversion using ABIC: Application to the 1997 Manyi, Tibet earthquake with InSAR and seismic data

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We can observe geological and geophysical phenomena by various ways. For example, we observe the occurrence of an earthquake by strong motion seismometer, broadband seismometer, GPS, InSAR, leveling, and so on. On the other hand, from these data, we can estimate a fault model by inversion analysis. If we use more data, we must get a better model.

In the inversion analysis, if we use only one sort of observed data, the method is easier, because we can assume that the variance of data is the same for all the data used. When we use more than one sort of data, however, we cannot put such assumption that the variance of all the data is the same. Of course, we can subjectively set the value of variance for each kind of data, as we do in the damping least square method in determining the relative weight. The model estimated by such method, however, is statistically not the most plausible model. In the present study, we give an inversion algorithm to objectively determine the variance of each kind of data, based on Akaike's Bayesian Information Criterion (ABIC).

We apply this technique to the Mw 7.6, 8th November 1997 Manyi earthquake in central northern Tibet. The input datasets are three short-interval ERS-2 interferograms from adjacent tracks that cover the coseismic deformation, and vertical component (P-wave) data from 10 Global Seismic Network stations at teleseismic distances from the epicentre. The Manyi fault is approximated by a 180 km x 18 km vertical fault, divided into 6 x 6 km subfaults. We invert both datasets separately, and then jointly, using ABIC.

We find that the InSAR data place a very strong constraint on the spatial pattern of fault slip obtained, with the joint model bearing a strong resemblance to that of the InSAR-only model. Although the slip pattern for the joint model strongly differs from that obtained by inverting the seismic data alone, we find that it can be accommodated by the seismic data with very little degradation to the fit from that obtained by the seismic-only model.

The joint inversion method we have developed here can be applicable to general linear inverse problems.